

INDIANA DEPARTMENT
OF
TRANSPORTATION

**APPLICANT'S GUIDE
TO
TRAFFIC IMPACT STUDIES**

Final Report

APPLICANT'S GUIDE TO TRAFFIC IMPACT STUDIES

Souyma S. Dey
Graduate Research Assistant

Jon D. Fricker
Professor of Transportation Engineering

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FOREWORD

This guide, entitled "Applicant's Guide to Traffic Impact Studies," is a product of an HPR study called "Guidelines for Traffic Impact Analysis of Developments Along State Highways." The study was conducted by the Joint Highway Research Project (JHRP) in the School of Civil Engineering at Purdue University in conjunction with the Indiana Department of Transportation (INDOT) and the Federal Highway Administration (FHWA).

At the time the study was undertaken, a need was identified to establish a standardized procedure or guidelines for requesting, preparing, and/or reviewing a traffic impact analysis for a proposed development that would affect state highways. Cases of rezoning and building permits were handled at the local level (city or county), each of which had its own guidelines for such studies, if any. INDOT handled new developments when access driveway permits were necessary. Often, INDOT is not involved in the transportation aspects of a site's development until access permits are requested for access to state routes. This can occur too late in the development's construction for any traffic-related problems to be remedied as effectively and economically as they could have been in the planning stage. Also, the need was identified for greater coordination between INDOT and the local agencies in this matter.

This guide is a first step in that direction. It is designed to be compatible with the Applicant's Guide and Procedure Manual for Transportation Impact Studies for Proposed Development for the City of Indianapolis [21,22].

The ideas and concepts in this guide borrow from the composite experience and effective procedures of numerous agencies and practitioners. It also incorporates, and in some cases enlarges and adjusts upon, accepted procedures as documented in other standard references, especially:

- ITE Recommended Practice -- Traffic Access and Impact Studies for Site Development [1]
- Transportation and Land Development [2]
- Site Impact Traffic Evaluation Handbook [3]
- ITE Trip Generation [5]

An expanded version of the Applicant's Guide, called the "Reviewer's Guide to Traffic Impact Studies," contains a more detailed description of some of the analytical techniques available to the traffic impact study preparers. The guides recognize that traffic impact analysis is a site-specific issue that can depend on many variables, such as the amount and type of data available and certain other local parameters. Instead of prescribing a specific procedure for every step, the guides allow for consideration of various options to obtain specific results. Therefore, they allow enough flexibility for the study preparer to use innovative methods based on sound engineering judgment. However, this should be done with the prior consent of the study reviewer(s).

The Study Advisory Committee assisting in the preparation of the guide was comprised of:

- Mr. Ed Ratulowski (FHWA)
- Mr. Jose Campos (FHWA)
- Mr. Robert Cales (INDOT)
- Mr. Mark Newland (INDOT)
- Mr. Jim Poturalski (INDOT)
- Mr. Clint Venable (INDOT)
- Mr. Dwane Myers (INDOT)

Input was also received from a panel of consultants before the final draft of the guide was prepared.

CHAPTER 1

INTRODUCTION

A Traffic Impact Study (TIS) is a specialized study of the impact that a given type and size of new land use has on the nearby transportation system. TIS has become popular as a planning tool so that effective mitigating measures can be taken in advance. In fact, in some regions, a Traffic Impact Study is mandatory for any developments larger than a few single-family dwelling units.

The main purposes of Traffic Impact Studies are [22]:

1. To ascertain the operational conditions on the adjacent roadway network when a proposed development is accommodated within the existing transportation infrastructure along with other proposed developments (as reflected in the Comprehensive Development Plan).
2. To identify transportation improvements required to maintain the existing operational conditions.
3. To determine whether access to the proposed development will hamper traffic operations and safety near the site.
4. To identify present or future transportation system deficiencies without the new development.
5. To provide decision makers with a basis for assessing the transportation implications of approving proposed zoning changes and development applications.
6. To provide a basis for estimating the cost of proposed mitigating measures. Consequently, a traffic impact analysis can be used to determine the "fair share" of the improvement cost to be paid by the developer.

PURPOSE OF THE APPLICANT'S GUIDE

This guide is intended to establish a standard methodology for Traffic Impact Studies. This would result in consistency in study requests, preparation and review. Such a standardized procedure would be beneficial to everyone involved in the development process. First and foremost, the guide will lead the study preparer through a step-by-step procedure and enable him or her to present the study findings and recommendations in a systematic manner consistent with the reviewer's expectations. Second, it will enable reviewers to evaluate the study in a systematic manner. Finally, it will promote understanding and awareness of transportation-related issues among those involved in the development procedure.

The guide is not intended to make things more complicated and time-consuming; on the contrary, in the long run, as the assumptions and procedures become accepted practice, the time involved in the process will decrease for both parties.

CHAPTER 2

PREPARER AND REVIEWER QUALIFICATIONS PREPARER QUALIFICATIONS

Traffic Impact Studies should be prepared by a transportation professional with training and experience in traffic engineering and transportation planning. It must be prepared by or under the supervision of a registered professional engineer with experience in traffic engineering operations. The study should contain a statement of certification as follows:

*"I certify that this TRAFFIC IMPACT STUDY has been prepared by
me or under my immediate supervision and that I have experience and
training in the field of traffic and transportation engineering.*

(signed)

John O. Smith, P.E.

Indiana Registration 12345

Consulting Firm, Inc."

REVIEWER QUALIFICATIONS

The Traffic Impact Study shall be reviewed by one or more of the professional staffs of the Indiana Department of Transportation and any other participating agency (Department of Metropolitan Development, Department of Planning, City, County, etc.) who collectively have training and experience in Traffic Impact Study methodology, land use planning and traffic engineering, including traffic safety and operations.

ETHICS AND OBJECTIVITY

Although study preparers and reviewers might have different objectives and perspectives, they should adhere to established engineering ethics (similar to the Canon of Engineering Ethics) and conduct all analyses and reviews objectively and professionally.

CHAPTER 3

STUDY PROCEDURE

Typically, a Traffic Impact Study (TIS) should be considered in conjunction with an application for approval of any of the following:

- zoning changes
- subdivision/platting
- site plan
- building permit
- driveway (access) permit
- comprehensive plan amendments requested by the developer

However, INDOT gets involved in the Traffic Impact Study procedure only when access permits are requested for driveway access to state highways.

The proposed process of Traffic Impact Study will consist of one, two, three, or four steps, depending on the type of development under consideration. The different stages of a Traffic Impact Study procedure are discussed below.

Step 1. A preliminary notification will be required of all developments meeting certain "preliminary warrants." These are presented in Chapter 4 of this guide. If any of the development's predictor variables exceeds the preliminary threshold values, the developer must provide INDOT with the information that comprises a "preliminary notification" (see Chapter 4) and request that an "initial meeting" with INDOT be scheduled (see item 2 below). If the development under consideration does not exceed the preliminary warrants, no further action is required and the TIS procedure stops here.

Step 2. At a mutually convenient time, approximately 2-3 weeks after the preliminary notification has been received, representatives of the developer and INDOT should hold the initial meeting. Based on additional information gathered since the preliminary notification, the two parties decide if a more detailed Traffic Impact Study is necessary. (See Chapters 5 and 6 for guidance.) From the findings of the preliminary study, it will be determined if warrants for a complete TIS are met (Chapter 6). If the warrants are met, then a detailed Traffic Impact Study (discussed in Chapters 8 through 15) will be required for the development. If the warrants are not satisfied, go to item 3 (below); otherwise go to item 4.

Step 3. This step involves determining whether the warrants of a traffic operations analysis are met. If the warrants are met, then a traffic operations analysis has to be conducted (Chapter 7). If the warrants for a traffic operations analysis are not met, the study procedure stops here. Otherwise, go to item 4 (below).

Step 4. This step involves the staff review (Chapter 16) of the traffic operations analysis or the Traffic Impact Study. If the analysis or study are satisfactory, the process stops here. Otherwise, the revisions suggested have to be incorporated and sent back for further review. This is the last step in the study process.

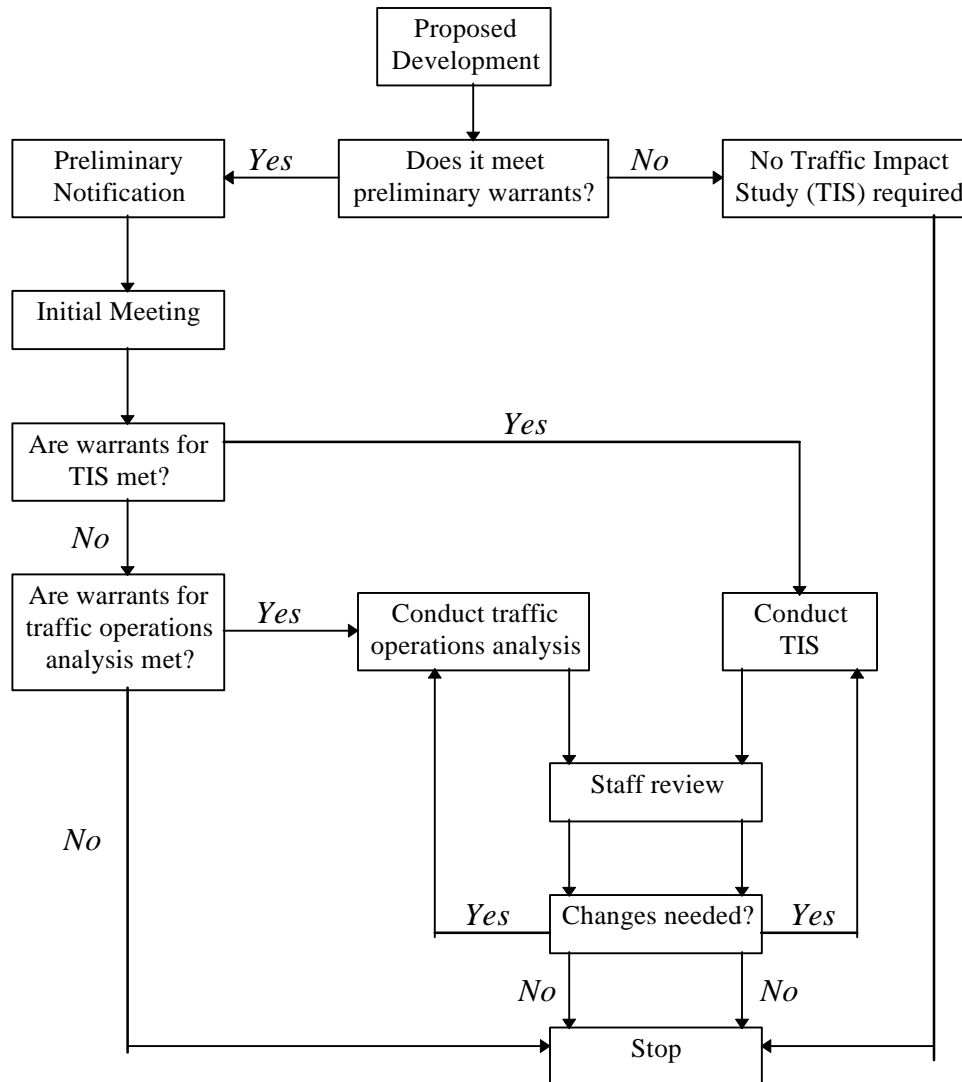


Figure 3.1. Flowchart Showing the Traffic Impact Study Procedure

CHAPTER 4

PRELIMINARY NOTIFICATION

A preliminary notification to INDOT will be required of all developments that meet the preliminary threshold values for Traffic Impact Studies. The preliminary notification should include:

- the type of development
- the complete site plan, with the site's access points and the nearest signalized intersection in each direction
- a market study (if applicable)
- trip generation values and the method(s) used to compute them

The preliminary notification need not be a detailed analysis of the present and future conditions. No elaborate data collection effort or computer modeling is necessary for the notification. It is intended to provide an approximate description of existing and anticipated traffic conditions and is supposed to provide a foundation on which to base discussion during the initial meeting. The state department of transportation or the local transportation agency may be contacted for any existing data that are available to help prepare such a description.

The preliminary notification should be submitted along with the petition for an access permit.

PRELIMINARY WARRANTS

A preliminary notification will be required of all developments that meet the "preliminary threshold values" or "warrants." The preliminary warrants are based on certain predictor variables associated with the proposed development at full "build-out", such as gross floor area, acreage, etc. Table 4.1 shows the threshold values of the predictor variables for different land uses. Developments having land use intensity greater than the threshold values qualify for the preliminary notification action.

Table 4.1. Preliminary Warrants for Traffic Impact Studies

<i>Land Use Type</i>	<i>ITE Code</i>	<i>Threshold Values</i>
Residential	210, 220, 222, 230, 270	150 Dwelling Units
Retail	814, 815, 820	15,000 square feet (1400 square meters)
Office	710, 714, 715, 750, 770	35,000 square feet ((3250 square meters) or 3 acres (1.2 ha)
Industrial	110, 120, 130, 140	70,000 square feet (6500 square meters) or 9 acres (3.6 ha)
Educational	520, 530, 550	30,000 square feet (2790 square meters) or 250 students
Lodging	310, 312, 320	120 occupied rooms
Medical	610	46,000 square feet (4270 square meters)

Special generators with high trip generation rates, such as parking garages, banks (both drive-in and walk-in), fast food restaurants, and service stations with convenience stores, will require a preliminary notification unless a waiver (for roads not under INDOT jurisdiction) is obtained from the local public transportation agency (city, county, etc.) concerned. The reviewer(s) will decide whether a waiver is justified, based on experience and engineering judgment.

For mixed-use developments, for developments that cannot be grouped under one of the land use categories given in Table 4.1, or for those discussed in the previous paragraph, the estimated trip generation rates should be determined using the latest available edition of the ITE Trip Generation report. If the development under consideration will produce more than 50 street peak period major direction vehicle trips, then the preliminary warrants are satisfied. For developments that generate considerable truck traffic, the truck trips should be converted to equivalent vehicle trips.

Developments that do not exceed the preliminary threshold values will not require any Traffic Impact Study to be conducted.

CHAPTER 5

INITIAL MEETING

If the values for a proposed development exceed the preliminary warrants (Table 4.1), an initial meeting between the developer's representative and INDOT personnel should be scheduled. Depending on the development, the type of information to be discussed at the meeting, and the way in which an INDOT jurisdiction (normally the District Office) has organized its functions, the following INDOT personnel may need to attend the initial meeting:

1. Regulatory Supervisor
2. Traffic Engineer
3. Development Engineer

For brevity, the developer's representative will hereinafter be referred to as the Traffic Impact Study "preparer" and the INDOT personnel responsible for reviewing the study will be referred to as the Traffic Impact Study "reviewer."

The discussions in the initial meeting between the preparer and the reviewer will be based on the information in the preliminary notification. The initial meeting will serve the following purposes:

1. To determine whether a detailed Traffic Impact Study or traffic operations analysis is required for the proposed development.
2. If further studies are required, the meeting will help the study preparer understand the reviewer's expectations.
3. To discuss critical issues such as (but not limited to) the extent of the study, the study area, the horizon years, time periods to be analyzed, data sources, and availability.
4. To ensure that all relevant issues are adequately addressed in the Traffic Impact Study, and that no extraneous elements are included in the study.

If a Traffic Impact Study is warranted (see Chapter 6), some of the issues that will need to be addressed in the initial meeting are discussed below. A more detailed description of some of these issues appears in the INDOT Reviewer's Guide to Traffic Impact Studies.

STUDY AREA

Any Traffic Impact Study should include at least all site access points and major intersections adjacent to the site. The first signalized intersection on each street serving the site should also be analyzed, if it is within 1/2 mile or one cycle length of travel time of the site. Beyond this area, the reviewer and the preparer should jointly determine additional area to be analyzed, based on site-specific issues. Sound engineering judgment should be used to include all areas that may directly or indirectly be impacted by the proposed development.

HORIZON YEARS

The horizon year of a TIS should refer to the anticipated completion date of the proposed development assuming full build-out occupancy.

TIME PERIODS TO BE ANALYZED

The critical time period for any development will be directly associated with the peaking characteristics of both the development and the adjacent roadway system. Special consideration should be given to developments like shopping centers, which might peak after the adjacent street peak or on a Saturday. The following time periods should be considered during the initial meeting:

- AM and PM street peak (weekday)
- AM and PM site peak (weekday)
- Noon peak (weekday)

FUTURE OFF-SITE DEVELOPMENT

Most studies should take into account future off-site developments to ascertain the "base condition" in the horizon year. Both the reviewer and the study preparer should agree on off-site development assumptions for the horizon year. In case of a failure to reach an agreement, the reviewer will designate the quantity, type, and location of developments to be assumed in the study.

DISCUSSION CHECKLIST

A discussion checklist has been provided in Appendix A to aid both the parties in recording information and comments. However, the discussions should not be restricted to the issues addressed in the checklist. INDOT's checklist has been developed in line with that used by the City of Indianapolis. Larger developments in densely developed areas will need more in-depth discussion, while smaller sites may not need discussion on many of the issues in the checklist. Table 3.2 in reference [1] lists typical data that may be needed for a Traffic Impact Study.

MEMORANDUM OF UNDERSTANDING

Immediately after the initial meeting, the study preparer should submit a memorandum of understanding confirming the following [21]:

- issues to be addressed in the study
- study procedure
- assumptions
- data sources
- report content
- other pertinent issues discussed in the initial meeting

The memorandum should request concurrence by the reviewing agency staff representative.

STAFF CONCURRENCE

The contents of the Memorandum should be evaluated by the reviewer. If all elements are agreed upon, staff concurrence should be communicated in writing to the study preparer.

CHAPTER 6

WARRANTS FOR A COMPLETE TIS

A formal Traffic Impact Study will be requested for any development that meets any of the warrants described below:

Warrant 1. Land Use Intensity

This warrant is satisfied when a development generates more than 100 street peak hour direction trips.

Warrant 2. Level-of-Service Warrant

This warrant is satisfied if the traffic generated by the proposed development causes the level-of-service (LOS) of the adjacent streets/intersections to drop to a "C" or lower, or where nearby intersections presently operate at level-of-service "D" or worse. LOS determination should be in accordance with the procedures described in the Highway Capacity Manual [13], using data provided by or approved by the reviewer.

Warrant 3. Roadway Modifications

This warrant is met when the proposed development is expected to significantly impact a roadway segment identified for improvement in the Transportation Improvement Program. This criterion is also met when the proposed development includes modifications to the roadway system. Modifications include addition of lanes to accommodate site-generated traffic, addition of exclusive turning lanes, acceleration/deceleration lanes, median openings, installation of traffic signals and other traffic control devices, etc.

Warrant 4. Special Cases

This warrant is satisfied if the preliminary study reveals that the traffic generated from the proposed development will create safety, operational, or some other traffic problems. Whether a development meets this warrant should be decided at the initial meeting.

CHAPTER 7

TRAFFIC OPERATIONS ANALYSIS

Typically, a traffic operations analysis is conducted whenever a proposed development compromises the existing design standards and therefore may cause safety and operational problems in the immediate vicinity of the site. The analysis should be done for the entire system and not just the driveway or access point under consideration. A traffic operations analysis might include:

1. Study of proposed driveway locations, resulting sight distances, queuing provisions, etc.
2. Safety analysis
3. Traffic signal warrants and progression analysis
4. Delay analysis
5. Gap studies

WARRANTS FOR TRAFFIC OPERATIONS ANALYSIS

A traffic operations analysis will be required if one or more of the following conditions is/are satisfied:

1. A development generates sufficient turning movements into or out of the development to require an auxiliary lane, such as an acceleration/deceleration lane, passing blister, or separate turn lane.
2. Request for new or modified driveways near intersections or interchanges.
3. Requests or probable need for a new (or modified) traffic signal to control driveways or streets serving a proposed or existing development(s).
4. Existing sight distance limitation or high accident location near the site.
5. Requests for median openings.

CHAPTER 8

NON-SITE TRAFFIC ESTIMATE

For estimating the traffic impacts of a proposed development, it is essential to analyze the traffic conditions on the horizon year roadway network for two cases: (a) with the proposed development, and (b) without the proposed development. The incremental impacts are attributed to the site-generated traffic. For this, a "base condition" must be established. The base condition will correspond to the traffic that would exist in the study area in the horizon year without the proposed development. This traffic is commonly referred to as non-site traffic. Non-site traffic may be of two kinds [2]:

- Through traffic, which has neither an origin nor a destination in the study area
- Traffic that has either an origin or a destination or both in the study area. This traffic is generated by other developments in the study area

Non-site traffic estimation may be done by one of three methods:

1. Build-up
2. Area Transportation Plan or Area-wide Model
3. Trends or Growth Rate

See references [1] and [32] for detail.

CHAPTER 9

TRIP GENERATION

Trip generation involves estimating the number of trips that will be produced from or attracted to the proposed development. This is one of the most important steps in Traffic Impact Studies.

ACCEPTABLE DATA SOURCES

Several sources and methods of obtaining trip generation data are available and can be used:

1. ITE TRIP GENERATION REPORT [5] -- This report allows estimates of trip generation based on three different options:

- rate
- regression equations
- scatter plots

The estimates obtained from this source must be used with good judgment [27], as they are based on national data and would fail to take into account any special features that the local subject site might have.

2. OTHER NATIONAL DATABASES-- Two other possible sources for estimating trip generation are NCHRP 187 [16] and Development and Application of Trip Generation Rates [4]. The former contains trip generation rates for a variety of land uses, mostly suburban. The latter is essentially an updated version of the former, with some statistical measures of variances of the data.

3. STATE AND LOCAL DATA-- Many states and regional and local agencies have trip generation rates for sites within their jurisdiction. Appropriate agencies can be contacted to examine whether such data is available. The advantage of working with local data is that it will be more representative of the site under consideration than national data. The drawback is that the number of local sites is usually too small for a strong statistical model.

4. PRIOR STUDIES -- Data from prior studies made on a similar kind of land use under similar conditions may also be used.

5. DATA COLLECTION-- If existing data are not available or are not a good representation of specialized characteristics that the site under consideration might have, a data collection effort has to be conducted at sites that exhibit similar characteristics as the study site.

MIXED-USE DEVELOPMENTS

In case of mixed-use developments, certain deductions, may have to be made to the trip generation rate derived by adding the trip generation rates of the individual land uses to accommodate the possibility of internal trips. Mixed-use developments are discussed in Chapter 13 of this guide.

PASS-BY TRIPS

The methodology for handling pass-by trips is discussed in detail in Chapter 12 of this guide.

CHAPTER 10

TRIP DISTRIBUTION

After the trip generation estimates have been made, it is necessary to distribute these trips to make an assessment of the impacts of the proposed development. The outcome of the trip distribution method will be origin-destination data for generated trips.

Four methods of trip distribution are commonly used. These methods are described in references [1, 2, 25, and 32]. Trip distribution using gravity models may be conducted manually or by computer. In either case, the preparer must document the procedure properly. Local Metropolitan Planning Organizations (MPO's) have data by zones that might be used. The procedure, whether manual or computerized, produces direction-of-approach information and reduction in site traffic at an increased distance from the site. Hence, the gravity model approach is useful when it is necessary to evaluate the traffic impacts of developments on intersections at a certain distance from the site. This method, however, should be used for large projects. For small distances from the site, the estimates are too rough.

CHAPTER 11

TRAFFIC ASSIGNMENT

Traffic assignment involves assigning the distributed trips to specific paths in the road network. Hence, the product of traffic assignment will be the total project-generated traffic by direction and by turning movements on the horizon year roadway network in the study area. Assignment should be made after taking into account logical routing, available roadway capacities and projected and perceived minimum travel times. Multiple paths should be assigned between origins and destination rather than assigning all of the traffic to the route with the shortest travel time.

The assignment may be done manually or by computer.

Procedures for assigning site and non-site trips are the same.

CHAPTER 12

PASS-BY TRIPS

Shopping centers and several other convenience-oriented land use types like banks, gas stations and fast food restaurants have trip characteristics different from other land use developments. A significant portion of their trips are "captured" from the adjacent traffic stream. These trips already existed before the development. Trips to such developments may be broken down into 3 categories [5, 9, 10]:

- Primary
- Diverted Linked
- Pass-By

Figure 12.1 shows a schematic diagram representing primary, diverted linked, and pass-by trips.

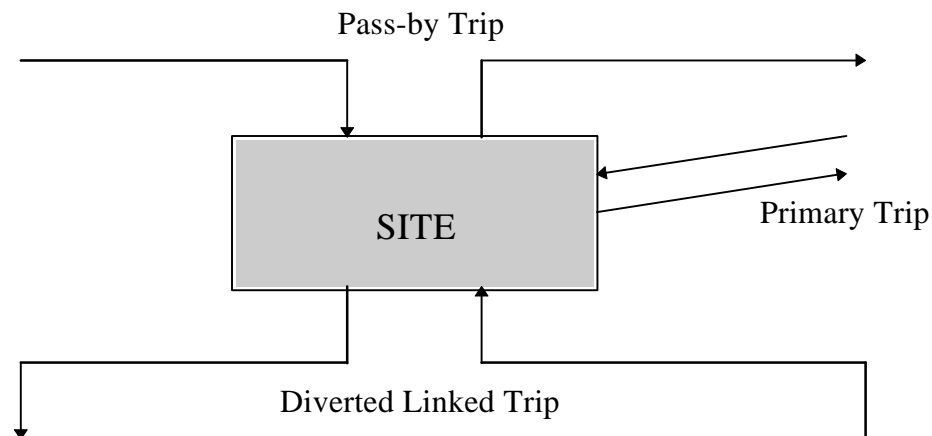


Figure 12.1 Schematic Diagram Showing Primary, Pass-By and Diverted Linked Trips

A pass-by trip destined to a retail facility is one in which the purpose of the trip is shopping at the site and the pattern of the trip is home-shopping-home.

A diverted linked trip to a retail facility is one in which the shopping destination is a secondary part of the primary trip. An example pattern of a diverted linked trip is work-shopping-home, the primary trip being from work to home with a secondary trip to a shopping center. Thus the diverted linked trip involves a route diversion from roadways elsewhere in the area to roadways adjacent to the site to reach a retail facility. The pass-by trip comes directly from the traffic stream passing the facility on the adjacent

roadway system and does not require a diversion from another roadway. The percentage of pass-by trips varies with the size and type of development, its geographical location, time of day, and the nature of the roadway system. It is evident that all trips are not new to the area and a reduction in the effective trip generation rate is justified. However, it is incorrect to simply reduce the trip generation rate by the estimated pass-by percentage. This would fail to take into account the actual distribution of traffic around the site, which can have a significant impact on the outcome of the analysis. The pass-by trips can significantly impact the turning movements once the site becomes operational.

CHAPTER 13

MIXED-USE DEVELOPMENTS/INTERNAL TRIPS

Mixed-use developments refer to activity centers that have a number of different land uses. In such cases it is often inappropriate to simply add up the trip generation rates of the individual land uses to determine the trip generation rate of the entire development. This is because some individuals will visit two or more destinations without leaving the site. Therefore, to estimate the trip generation rates of such developments, the number of internal trips have to be estimated and subtracted according to the following formula:

$$\text{Trips}_{\text{mixed-use developments}} = \sum [\text{Trips}_{\text{individual land uses}}] - \text{internal trips}$$

In the absence of local or site-specific data, the percentages given in NCHRP Report 323 [15] and ITE Trip Generation [5] can be used as a guideline for determining the percentage of internal trips.

CHAPTER 14

ANALYSIS

Several analyses are necessary to derive the study findings, recommendations and conclusions. The different analyses that might be required are:

- capacity analysis
- safety
- site access points
- traffic control needs
- progression analysis
- median openings
- on-site circulation and parking
- neighborhood impacts

For each horizon year, the analysis should be performed for the critical time period for conditions with and without the proposed development. The incremental impacts can be attributed to the subject site.

The analysis should not be ended until one of three conclusions has been reached:

1. The proposed development can be accommodated in the horizon year transportation infrastructure with no additional improvements.
2. The proposed development can be accommodated in the horizon year transportation infrastructure consistent with agency policy and operating conditions subject to the recommended improvements/modifications.
3. The area will operate below the accepted level of service even without the development. No further significant deterioration will result if the proposed development is accommodated with the recommended changes.

CAPACITY ANALYSIS

Capacity analysis should be performed at all proposed site access points **and** intersections -- both signalized and unsignalized in the study area. Other critical and congested areas of the roadway network should also be identified for analysis by the reviewing agency. Elements such as freeway weaving sections, ramps, etc., might also require capacity analysis.

Capacity analysis should be consistent with the methods described in the 1985 edition of the Highway Capacity Manual (HCM) [13]. The latest available FHWA version of the Highway Capacity Software should be used for capacity analysis.

SAFETY ANALYSIS

Safety analysis should include identification and recommendations about high accident locations, restricted sight distances, and pedestrian safety. The key elements are listed below:

- accident experience [21]
- sight distance [14]
- pedestrians and bicycles [13]

SITE ACCESS POINTS

To satisfactorily provide site access and maintain acceptable operational conditions on streets adjacent to the site, the agency's access control policy and standard principles must be followed. In case of multiple driveways at a site, transportation-related needs for more than one driveway must be demonstrated.

Both street peak and site peak should be taken into consideration while analyzing the site access points. All site access points should conform to the latest edition of the Indiana Department of Transportation Driveway Permit Book.

Provisions should be made for vehicular storage.

TRAFFIC CONTROL NEEDS

Analysis should be carried out to determine whether traffic control warrants are met. Such warrants may be warrants for traffic signals, stop signs or yield signs. The warrant analysis should be according to the Indiana Manual of Uniform Traffic Control Devices (Indiana MUTCD) [23].

MEDIAN OPENINGS

If a median opening is requested, a detailed analysis should be carried out to find out whether a median opening would hamper the operating condition of the roadway. Due consideration should be given to the following:

- warrants for a left turn signal at the opening [20]

- approach speed of the opposing vehicles
- gaps in opposing traffic
- storage space at the median opening
- queuing and delay to the vehicles
- distance from the nearest intersection
- spacing between median openings [2, 31]

ON-SITE REVIEW

In most cases, on-site review will not be included in a Traffic Impact Study. For very large projects, where internal circulation system is critical, on-site review may be necessary. On-site review should include review of internal circulation and parking.

Parking

ITE Parking Generation[26] can be used to estimate parking demands. Parking should be requested and well documented. In case of shared parking between mixed-use developments, guidelines provided in Shared Parking[29] should be followed.

Internal Circulation

Internal circulation should provide access to all areas in a manner easily understandable to the drivers. Internal roadways should be marked and signed in accordance with recommendations in the Indiana Manual of Uniform Traffic Control Devices[23]. Considerations should be given to service and delivery vehicles and emergency vehicles in site design.

NEIGHBORHOOD IMPACTS

Neighborhood transportation impacts are primarily caused by site-generated traffic using neighborhood streets as short cuts. This can hamper pedestrian safety, air quality, community cohesion and, consequently, property values. Most neighborhoods are sensitive to this and hence an analysis should be conducted to estimate the neighborhood impacts of the proposed development and mitigating measures suggested.

KEY POINTS CHECKLIST

The following key points should be addressed in the analysis before preparing the final conclusion and recommendation:

1. Show all calculations. Show how all numbers/factors were obtained. This may be handwritten and placed in a separate appendix.
2. Show demographic information and calculations.
3. Show how the development's driveway's enter/exit percentages were obtained.
4. Draft plans to scale. Show measurements between all driveways (both existing and proposed), streets, rail crossings, etc.
5. Show and label all driveways, streets, and rail crossings from and adjacent to the development on scale plans. Show adjacent signalized intersections with measurements.
6. Show the development's connections to existing signalized intersections, or existing non-state streets.
7. Note all references used, including page numbers, equations, table/figure numbers, etc. Note reference information in the report at the point it is used.
8. Provide applicable copies from references used if INDOT does not have this reference.
9. Use Highway Capacity Manual/Software (current edition/version) for capacity studies.
10. From the development and along existing arterial roadways, assess the impact of the new traffic on operation of through streets. For simple cases, the required analysis may consist of a time-space diagram. For complex cases, computer programs, such as TRANSYT-7F, PASSER, TRAF-NETSIM, COPTRAFLO, SIGNAL-85 and/or other programs which are pre-approved by INDOT, should be used for analysis. This should include entire adjacent signal systems, both with and without the proposed signal at the development.
11. Perform a gap analysis on a driveway where a signal is requested. Take into account adjacent signals. Gap analysis of other proposed drives on-site may be requested.
12. Compute trip generation for signal warrants using initial development. (Do not include future expansions.)
13. Compute trip generation for geometric changes (turn lane lengths, etc.) using total build-out figures. Give dates for planned expansions. Show percent growth in volume used.
14. On the signal warrant analysis, justify the percentage of right-turns-on-red used.
15. Provide preliminary signal timings for the proposed provisional traffic signal. If the proposed signal would be included in an existing traffic signal system, then the revised times for the complete system shall be provided.
16. If there are any major traffic generators nearby, collect data and show how it will affect the development.

17. Show exact locations where counts were obtained. Tell how and when counts were taken.
18. Provide justifications for all driveways requested.
19. Provide copies of raw data.
20. Label all forms completely. Make sure copies are clear and legible.

CHAPTER 15

CONCLUSIONS AND RECOMMENDATIONS

If the Traffic Impact Study reveals that the projected traffic volumes on the horizon year roadway network will operate in a safe and efficient manner at an acceptable level of service, then no improvements are required. However, if deficiencies are detected, mitigating measures have to be recommended. These measures may include:

1. Installation of traffic signals.
2. Installation of traffic control signs.
3. Addition of lanes.
4. Addition of acceleration/deceleration lanes.
5. Restriction of turning movements.
6. Adjustment of cycle lengths.
7. Introduction of additional signal phases.

However, if reasonable mitigating measures cannot be found to make the traffic operate in an efficient way, a more detailed evaluation of project size, land use types, and development phasing may be required. If viable transportation improvements cannot be recommended, then steps have to be taken to reduce the trip generation rate of the proposed development during the problem period. Some of the possible approaches that may be adopted are:

- increased transit usage
- car-pool/van-pool programs
- congestion pricing
- reduced parking or increased parking fees
- staggered work schedules

Any transportation demand management recommendations should take into account [22]:

1. Timing of the short-range and long-range transportation system improvements that are already scheduled or anticipated.
2. Anticipated timing of adjacent developments.
3. Phasings of the subject development.
4. Right-of-way needs and availability.
5. Local priorities of transportation improvement funding.
6. Cost-effectiveness of the proposed improvements.

RECOMMENDED PLAN OF ACTION

Implementation recommendations should be presented as a "plan of action. This action plan should recommend improvements, state why they are needed, and when they are to be implemented.

CHAPTER 16

THE REPORT

The Traffic Impact Study report should document the purpose, procedures, data sources, assumptions, findings, conclusions and recommendations of the study. It should be concise and complete. The report should be organized in a logical sequence and methodically take the reader through the entire process of the Traffic Impact Study. It should be kept in mind that the report might be of interest to the decision makers and other non-technical people. Hence, clarity should not be sacrificed.

The report format presented below provides a uniform framework that will facilitate both the preparation and the review of the report. Any major departures from this standard format should be agreed upon at the initial meeting and mentioned in the subsequent memorandum of understanding (see Chapter 5).

REPORT FORMAT

Report Cover and Title Page

See Appendix B

Table of Contents

Listing of all the chapters and major sections.

List of Exhibits

Some of the typical exhibits that could be included in a Traffic Impact Study are tabulated in Table 16.1. Because the exhibits actually needed will vary from study to study, list all the tables and figures included in the report by page number. Tables and figures may be identified by letter (as in Table 16.1) or by number, according to the study preparer's preference.

Executive Summary

Each Traffic Impact Study report should begin with an executive summary. It should be a one-page or two-page document to facilitate examination by the reviewing agency. It should contain the salient features of the study and should summarize the study purpose, and its conclusions and recommendations. Letters and memorandum reports under 10 pages do not need an executive summary.

Prototype Report Outline

A prototype report outline is given in Appendix B. It is intended to be an exhaustive list of items for the preparer and reviewer to consider at the initial meeting [33]. Many items may not apply to any particular proposed development, and need not be

included in the report. It is also possible that items not listed in Appendix B may be applicable to a particular site, as decided upon in the initial meeting.

Report Certification

Traffic Impact Studies shall be certified by the preparer (see Chapter 2). Such certification should state that the study has been conducted according to the methods described in this Applicant's Guide

A report for any of the limited studies or traffic operational analyses should state in the first paragraph that the reviewer directed or agreed that only a limited study be conducted.

PUBLIC RECORD

Traffic Impact Study reports become public record upon submittal. Information provided in the study can be used for subsequent studies.

Table 16.1 Typical Exhibits in a Detailed Traffic Impact Study[Source: Ref. 1]

<i>ITEM</i>	<i>TITLE</i>	<i>DESCRIPTION</i>
Figure A	Site Location	Area map showing site location and area of influence.
Figure B	Existing Transportation	Existing roadway system serving site. Should show system and all major & minor routes adjacent to the site.
Figure C	Existing and Anticipated Land Use	Map showing existing and anticipated land uses and developments in the study area.
Figure D	Current Traffic Volumes	Most recent traffic volumes on roads in the study area.
Figure E	Existing Peak Hour Turning Volumes	Current peak hour turning volumes at each location critical to the study.
Figure F	Anticipated Transportation	Area transportation system map showing programmed and applicable roadways; improvements, including transit, bikeways and pedestrian ways; improvements affecting site access or traffic flow through the study area.
Table A or Figure G	Directional Distribution	Map or table showing the proportion of site traffic approaching and departing the area on each roadway.
Table B	Estimated Site Traffic Generation	Analysis period site traffic generation by direction.
Figure H	Site Traffic	Map of horizon year roadway network showing peak hour turning volumes of site-generated traffic.
Table C	Trip Generation of Non-Site Development	Trips generated by off-site developments within the study area.
Figure I	Estimated Non-Site Traffic	Map showing peak hour turning volumes due to the developments in the study area and through traffic.
Figure J	Estimated Total Horizon Year Traffic	Peak hour turning movements in horizon year. (Sum of Figures H and I).
Figure K or Table D	Level of Service (LOS)	Level of service at critical locations under conditions and in horizon year with & without the proposed development
Figure L or Table E	Recommended Improvements	Table or figure showing improvements by location and type. If phasings of improvements are to be stipulated, they have to be shown.

CHAPTER 17

STAFF REVIEW

The purpose of staff review is to ensure that the Traffic Impact Study has been properly prepared and that the recommendations made by the preparer are realistic and implementable. Staff reviews are not intended to deter new developments. They are to ensure that traffic-related problems are anticipated and that effective mitigation measures are identified. If questions arise, contact between the preparer and the reviewer during the preparation of the TIS is encouraged.

Traffic Impact Studies should be reviewed by departments and agencies that are (a) responsible for operating the roadways and/or (b) planning and implementing roadway improvements that are likely to be impacted by the proposed development.

FORMAL REVIEW

This review is conducted after the report has been submitted by the preparer. The formal review process should produce a list of the following findings:

- Acceptable analyses and conclusions
- Unacceptable analyses and conclusions
- Acceptability of recommended site access provisions and roadway improvements
- List of required improvements that might be considered to mitigate impacts of the proposed development

Following the review, the reviewer(s) should send to the preparer a list of requested study revisions or a letter accepting the study.

REQUEST FOR REVISION

Any requests for study revisions should concisely indicate the findings of the formal review and clearly specify the additional information required. This additional report should be in the form of an addendum to the original study. In certain specific cases, a revised report may be requested.

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APPENDIX A

INITIAL MEETING CHECKLIST

Suggestion: Use this Appendix as a worksheet to ensure that no important elements are overlooked. Cross out the items that do not apply.

Date: _____ Time: _____

Location: _____

People Attending

Name, Organization, and Telephone Numbers

- 1) _____
- 2) _____
- 3) _____
- 4) _____
- 5) _____

Study Preparer

Preparer's Name and Title: _____

Organization: _____

Address & Telephone Number: _____

Reviewer(s)

Reviewer's Name & Title: _____

Organization & Telephone Number: _____

Reviewer's Name & Title: _____

Organization & Telephone Number: _____

Applicant

Applicant's Name, Address, & Telephone Number: _____

Proposed Development

Name: _____

Location: _____

Location within area:

CBD

Urban (Non-CBD)

Suburban (Non-CBD)

Suburban CBD

Rural

Freeway Interchange

Other (Specify)

Land Use Type:

ITE Code #: _____
Other: _____
Description: _____

Proposed number of development units: _____

Zoning

Existing: _____

Comprehensive plan recommendation: _____

Requested: _____

Findings of the Preliminary Study:

Study Type:

Complete _____ Traffic operations _____

None _____

Study Area

Boundaries: _____

Additional intersections to be analyzed: _____

Horizon Year(s)

Analysis Time Period(s)

Future Off-Site Developments

Source of Trip Generation Rates

Reductions in Trip Generation Rates

None _____

Pass-by trips _____

Internal trips (mixed-use developments) _____

Transit use _____

Other _____

Horizon Year Roadway Network Improvements

Methodology & Assumptions

Non-site traffic estimates: _____

Site-trip generation: _____

Trip distribution method: _____

Traffic assignment method: _____

Traffic growth rate: _____

Special Features(from preliminary study or prior experience)

Accident locations: _____

Sight distance: _____

Queuing: _____

Access location & configuration: _____

Traffic control: _____

Signal system location & progression needs: _____

On-site parking needs: _____

Data Sources: _____

Base maps: _____

Prior study reports: _____

Access policy and jurisdiction: _____

Review process: _____

Requirements: _____

Miscellaneous

=====

SIGNATURES

Study Preparer

Reviewers

Applicant

APPENDIX B

SAMPLE REPORT OUTLINE

Suggestion: Use this Appendix as a worksheet to ensure that no important elements are overlooked. Cross out items that do not apply.

Report Outline

- A. Development name and location
- B. Application number
- C. Applicant name
- D. Preparer name and organization
- E. Report date

Title Sheet

- A. Development name and location
- B. Application number
- C. Applicant's name, address and telephone number
- D. Preparer's name, title, organization, address and telephone number
- E. Date of original report
- F. Report revision date

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